Presentation

FULL DETAILS AND TRANSCRIPT

Developing Conceptual Understanding, Fluency, and Problem Solving

June 2008

Topic: National Math Panel: Critical Foundations for Algebra

Practice: Comprehensive Instruction

Highlights

- The mathematics coach leads a study session to discuss the difference of opinions among staff as to whether students need to memorize arithmetic facts before they're ready for more advanced concepts
- Simultaneously teaching conceptual understanding, computational fluency, and problem solving and the interrelations between them
- Lesson example of comprehensive teaching
- Developing fluency with basic arithmetic facts is key to developing conceptual understanding of mathematics
- The use of calculators with an example
- Value of using practice distributed over time in developing automaticity and improving fluency, including the use of technology-based tools
- Example of integrating practice into a lesson
- The relationship between student beliefs about learning and mathematics performance and the need for students to believe that effort matters

Full Transcript

Slide 1

Welcome to the overview on Developing Conceptual Understanding, Fluency, and Problem Solving.

Slide 2

Here are a few tips before we get started… Use the slide titles in the "outline" to jump to a specific section. Click on the "script" tab to follow along with the narration. Use the controls at the bottom to easily stop and start the presentation. Download any related files in the "attachments" folder; and show or hide the navigation using the windows icon.

Slide 3

Ms. Carlin, the newly hired mathematics coach at New Rivers' School District, begins the first of a series of study sessions about instruction on a topic that she knows is controversial. Whether or not students need to memorize arithmetic facts before they are ready for more advanced mathematics concepts is something that the teaching staff has never agreed upon. She knows this discussion will lead to other topics she wants to cover, such as: simultaneous development of skills, automaticity, practice, and the importance of student effort. Some teachers strongly assert that elementary mathematics instruction should first focus on memorizing the basic facts. Others argue that it should focus first on building children's conceptual understanding because they believe calculators largely eliminate the need to memorize facts.

Slide 4

Ms. Carlin explains that experts don't agree with either of these two positions. Instead, they recommend mathematics instruction that simultaneously develops students' conceptual understanding, computational fluency, and problem-solving skills.

Slide 5

Let's take a look at what simultaneous and comprehensive instruction entails.

Slide 6

While educators have long debated the relative importance of conceptual understanding, computational fluency, and problem solving, the National Mathematics Panel views these debates as misguided. These three aspects of mathematics knowledge should not be seen as competing for class time.

Slide 7

Far from being in conflict, learning in one of these areas facilitates and reinforces learning in the others. Emphasizing the connections between them and teaching them all together is much more effective than trying to approach them separately.

Slide 8

Mathematics instruction should aim to achieve: conceptual understanding of mathematical operations, competent use of operational procedures, and fluency with basic number facts. Each aspect helps students learn the other areas and affects learning of topics from estimation to word problems to computation. These jointly support effective and efficient problem solving.

Slide 9

What would this look like in a math lesson? A teacher sets up this problem: There are 25 beads in 2 bags. One bag had 7 more beads than the other. She first models putting 7 beads in one bag, subtracting 7 from 25, leaving 18 beads. Then, she and the students split the 18 beads evenly, placing 9 beads in each of the two bags. One bag has 9; the other bag has 9+7 beads. Solving the problem involves conceptual understanding of number composition, grasp of number facts, and competence with subtraction.

Slide 10

As the National Mathematics Advisory Panel points out, having students develop fluency with basic arithmetic facts is key in helping students to conceptually understand mathematics.

Slide 11

Students’ success with performing whole number operations depends largely upon automaticity or the ability to quickly retrieve basic arithmetic facts from long-term memory. Automatic recall reinforces their learning and improves their fluency.

Slide 12

The ability to efficiently retrieve basic arithmetic facts is integral to more complex, conceptual mathematical thinking and problem solving. Fluency with facts and algorithms frees up working memory for more complex aspects of problem solving.

Slide 13

While research doesn't provide answers about the consequences of long-term reliance on calculators, experts recommend that teachers avoid using them to replace mental arithmetic. Calculators may be used to extend learning, pose problems, and sometimes check the accuracy of computations, but students should not be dependent upon them.

Slide 14

In fact, calculators can be used to help build mental arithmetic skills. In a third grade classroom, for instance, a teacher might say, "Zana added 549 plus 286 on her calculator and punched just one wrong key. Her display shows 855. Which key was wrong?"

Slide 15

Teachers know that the key to developing fluency with facts is practice. However, practice is also important for developing student proficiency in operations, conceptual understanding, and problem solving as well. Let's take a closer look at what this means.

Slide 16

Adequate practice is essential for students to achieve the high levels of performance that automaticity makes possible.

Slide 17

The National Mathematics Panel suggests that effective practice should include a conceptually rich and varied mix of problems characterized by: presenting more difficult problems more frequently than less difficult ones, clearly highlighting relationships between problems, sequencing practice problems in ways that reinforce core concepts, and revisiting problems after a time delay to reinforce long-term memory.

Slide 18

Teachers can also take advantage of in-class practice time to conduct formative assessments. Well-selected problems can reveal students' misconceptions and identify where they make mistakes.

Slide 19

Integrating effective practice into a lesson might look something like this: Practice can be extended by making the problem more complex. A teacher starts with the earlier example of the beads sorted into two bags. We can extend his problem type in a number of ways. There are 34 beads in 3 bags; one bag has 7 more beads than the other two. Another example would be 125 beads in 2 bags; one bag has 7 more beads than the other.

Slide 20

Some of the tools already in use by teachers, such as technology-based tutorials, may improve students' performance in computation. If these computer-assisted reviews and practices are of high quality, they can be a useful tool for developing automaticity.

Slide 21

Just as important as practice and developing automaticity is the critical and often underappreciated concept of how students' beliefs about learning are related to their mathematics performance.

Slide 22

Research findings show that students' goals and beliefs about learning affect their mathematics performance. When children believe that their efforts to learn make them "smarter," they show greater persistence in mathematics learning.

Slide 23

Students, as well as their parents and teachers, need to believe that effort matters and that working hard, not just inherent talent, counts in mathematics achievement. Increased effort will engage students more in mathematics learning, which, in turn, can lead to improved mathematics grades and achievement.

Slide 24

Children's beliefs about the relative importance of effort and ability can be changed. Research suggests that for African American and Hispanic students, building efficacy in mathematics—building the belief that one's efforts can pay off in greater achievement—is particularly important in helping students succeed.

Slide 25

There are a number of ways to effectively support increasing student effort: Host a meeting for parents to share information about effort and persistence. Share information in parent and student newsletters. Ensure students are getting specific feedback on their work. Bring in an older student who has worked through difficulties and is now succeeding in high school mathematics. Acknowledge students when they show effort and persistence.

Slide 26

Let's check back in with New Rivers' teachers.

Slide 27

The semester's study sessions ended on a high note. New Rivers' teachers are beginning to share common thinking about mathematics instruction. They are developing lesson plans that simultaneously address conceptual understanding, procedural fluency, and problem solving. They have doubled their efforts to provide practice opportunities and acquired new software for computation practice. They're re-tuning messages about effort. Their students are less likely to say, "I can't do it" in favor of "I'll try again."

Slide 28

To learn more about comprehensive instruction, please explore the additional resources on the Doing What Works website.